DARK MATTER AS PAST MATTER (version 3)

Time share some aspects with DM. It never shows signs of instability, nor it is tangible. Despite huge scientific developments in the knowledge of the universe time still remains matter of discussion. [1, 2] Following Minkowski's description, it is as another dimension, [3] like space, in the four-dimensional universe of our current cosmological ΛCDM. [4, 5, 6] Its dimension crosses our three-dimensional space transversally, as a dimensionless point. Gravity interacts with matter through the centre of mass, which is also a dimensionless point. In this way mass puts in relation the time and the space dimensions. Without mass/energy there is no way of measuring time. Time is measurable, the question is if it is also physically existing. There is no apparent reason for not theorizing whether time dimension too, like space, may harbour mass. If so, then it must be one-dimensional and of the opposite sign with respect to the ordinary mass, lying totally to the negative side of the light cone, since evidently, we have no idea if a future time already exists. Spatial mass is positive, while temporal mass (from now on called *past mass*) must be negative. How to find evidence for such mass? Time is one-dimensional. It is measurable through the comparison of steady physical statuses from different moments. Any point in space, at every instant, i.e. each hyperspace-layer, is timeless. The peculiarity of time dimension, which makes it so different from the three space ones, is that we can measure no matter how far in past direction, while not at all in the opposite (future). The maximum velocity limit imposed in nature by the speed of light c makes anything slower than c, casually connected with the observer. Anything faster than c is out, in all terms. Our present, our worldline, travels towards the future and radiates all around at c speed. The same happens with the present of other events. We can see the present of a phenomenon only when its lightcone cross ours. That is to say when its light cone lateral surface crosses ours. We cannot literally watch outside such intersection, before or after that moment, slower or faster than c. Inside our lightcone facts are casually connected with us, it is the past. Those happening outside not. Light waves from the past reach us, one after another. Each observation is forced to catch one instant per time. The past might be there although, confined in the bulk, between the origin and the vertex of our lightcone, from the top of which we watch back (temporally back, though spatially around). Our line-of-sight is forced onto the two-dimensional flat lateral surface of the light cone. At every instant a spherical lightwave meets our observations, carrying all Universe's four-dimensional information on the two-dimensional image we intercept.

3.1. Ground assumptions and data

Despite no experimental data has been produced with the innovating idea of DM as past mass, there are still good reasons in its favour, when following those assumptions:

a. Universe is made of three indistinguishable space dimensions and one time dimension (time is one-dimensional);
b. Light travels at constant speed on the lateral surface of the observer's light-cone;
c. DM interacts with ordinary matter through gravitational interaction only;
d. DM has been found around galaxies, satellite galaxies and cluster of galaxies, for the most;
e. ΛCDM model mass/energy density observed for BM, DM and DE may scale 72.2%, 22.9% and 4.7%;
f. DM and time show strict correlation.

Summarizing DM show following features: it is stable (no decay has been observed), it is cold (non-interacting with strong, nor electroweak forces), it is time-correlated (with the evolution phase of the hosted galaxy), it is growing (along with star formation or outpacing the galaxy quiescence), it is massive (much more than hosted ordinary matter).

What we actually see, what we normally call observable universe, should be the physical phenomena met by our light cone in one instant of the past, for the limited speed of light cannot reach us instantaneously from anywhere (Olbers' paradox). Thus what we are used to guess as the universe content should be inferred from what our line

of sight catches in a given instant, the picture of that moment (or a collection of them).

The present mass, at one end of the arrow of time, must have existed also in the past. If time dimension is still there as the past light cone, then past mass should be there too. Now, while all four dimensions are taken into consideration when calculating universe quantities, observations are necessarily limited to two space dimensions only, as two-dimensional is the image of the front lightwave meeting us. The relations among those figures seem to suggest an underlying two-dimensional geometry: within them we can find the values 72.2%, 22.9% and 4.7%. Those proportions correspond to the radius of disc, its radius squared and the area. The same proportions could be applied to the above mentioned light cone on its radius and base. It would be feasible that if at every instant our line of sight catches, along the lateral surface of the light cone, the crossing of such radius, the latter would return a two-dimensional space-like timeless picture of the past. DM cannot be seen nor touched, its presence can be only inferred thanks to the gravitational interaction. If DM lies beyond our line of sight, temporally beyond, not spatially, we would not be able to literally see it. This may be why our entire estimation of the mass/energy density in the universe may belong mostly to past mass/energy. DM and DE may fill the gap between the origin and the present mass/energy according to the equations:

$$DM = BM^2. \qquad (1)$$

$$DM * \pi = DE. \qquad (2)$$

The radius carries the information of the gravitational weight of mass. An interesting similitude can be found in Newton's Law of Universal Gravitation, where the gravitational force is inversely proportional to the square of the distance between the two masses, distance also named radius, adding support to gravity as coupling time dimension with space. Law of Universal Gravitation however puts in relation two bodies interacting gravitationally. If their centre of masses would trace the crossings of time dimension with space, through which gravity may interact, then the analysis on BM, DM and DE would put our observation in relation with the rest of the universe as a whole.

Negative mass has, probably, [7] never been observed, though mathematically its existence is wholly consistent. [8] In theory, negative and positive mass should behave as follows:

- Positive mass attracts positive mass (gravitation);
- Negative mass repels both positive and negative mass (DE);
- For different signs, there is a push that repels the positive mass from the negative mass, and a pull that attracts the negative mass towards the positive one at the same time. That is to say that positive mass runs away from negative mass, which runs after it (the so-called runaway motion). [9]

Through computer simulations [10] experimental physics has tried to find out how LSS have formed, up to the situation of filaments we observe today. They run on the principle that pre-existing DM has gathered matter and then decayed and/or scattered. This paper aims to suggest instead that DM and DE may be born (almost) together with BM. Then the sticky DM and repulsive DE would have respectively attracted and pushed matter together, from the very start until today. Actual expansion of universe may be at the origin of the wider size of DM around BM (halos), given the huge time scale involved. Then DM halos from early universe should appear denser and smaller., e.g. as in a recent discovery, which showed a very ancient galaxy harboring a nut of dense DM. [11]

Conclusion

As already mentioned before, decades of experimental physics have not yet produced evidence of what DM really is, while making it absolutely necessary. The exact geometrical proportions in Equations (1) and (2), the observation on DM behaviour and the lack of to-date satisfying explanation should address the research to take into consideration a change of direction, regardless of how bizarre it may seem. At least to rule it out definitively. The innovation introduced by this paper is theorizing time as a physical existent quantity, measurable through the amount of cumulated DM, observed through the gravitational lenses. It is also inspired by the so-called *dark fluid*, repelling itself in the big voids, among the filaments of large-scale structures (LSS) and sticking to matter in

halos and clumps. [12] Within this frame if the most of the mass and most of the energy of universe really hide themselves within the negative nappe of the light cone, then they should respectively be DM and DE. The above conjectured existence of negative mass would also explain the direction of time arrow, forced by the runaway motion, consequent to the behaviour of mass of opposite signs. It would also be responsible for the growth of universe, both spatially (increasing the volume of the bulk) and temporally (pushing ahead our present on the edge of the light cone).

The research on galaxies and galaxy clusters velocities and direction of motion, their comparison with their DM halos would be able to demonstrate whether this study aims in the right direction. According to this conjecture a young or fast moving galaxy would not be able to gather enough matter to grow, since it would be lacking the important contribution from DM gravitational pull (not cumulating enough mass on a small space or time) showing consequently a thin halo condensation trail or lacking DM at all. Slow and/or old galaxies instead would exhibit wide and dense DM halos.

Despite cosmology of DM remains the main subject of this paper, however it unavoidably raises several questions within the particle physics of the Standard Model. While on cosmic scale it is still reasonable to enhance DM resolution in order to better define its behaviour, on the other hand, on the particles scale, it would be a unique challenge to reveal the existence of a messenger particle. Given the geometrical structure above mentioned, a hypothetical messenger particle of DM would correspond to that of gravitational interaction and be wholly time-like.

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